U.S. PATENT APPLICATION

FOR

A FLOSS FOR LIGHT TREATMENT OF ORAL STRUCTURES

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FIELD OF THE INVENTION

This invention relates generally to dental floss. More particularly, the present invention relates to floss capable of providing hygienic effects through the application of light.

BACKGROUND

In general, hygiene relates to the principles of cleanliness, promotion and preservation of health or the freeing from disease-causing microorganisms. Hygienic effects can be established in different ways of which one is through the effect of light on biological structures. For instance, the hygienic effect of visible, near ultraviolet and infrared light on

biological structures is known and has been described to provide anti-inflammatory effects, preventative effects, caries-protective effects, plaque-removing effects, teeth-whitening effects, heating effects, anti-bacterial effects, sterilizing effects, cleaning effects, cosmetic effects, therapeutic effects, healing effects, bio-stimulative effects, bio-altering effects, pain-releaving effects, agent-penetrating effects, photo-rejunivating effects and photo-dynamic treatment effects (See for instance a book by *Goldman* (1981) entitled *The biomedical laser: technology and clinical applications* and published by Springer- Verlag, New York; a book by *Katzir* (1993) entitled *Lasers and optical fibers in medicine* and published by Academic Press, New York; a book by *Hajder* et al. (1994) entitled *Acupuncture and lasers* and published by Ming, Belgrade; a book by *Tuner* et al. (1996) entitled *Laser therapy in dentistry and medicine* and published by Prisma Books, Grangesberg, Sweden; a book by *Alster* et al. (1996) entitled *Cosmetic laser surgery* and published by Wiley & Sons, New York; or a book by *Fitzpatrick* et al. (2000) entitled *Cosmetic Laser Surgery* and published by Mosby, St. Louis). The effects of a laser light on biological structures is dependent on the laser properties (active matter, beam wavelength, continuous or impulse mode of operation), characteristics of the structures, water content, pigmentation degree, vascularization, vitality, heterogeneity, specific heat conductivity or time exposure. The photo-effect of a laser can be applied to superficial structures and subcutaneous structures. As far as the mechanisms of laser radiation effects are concerned, they may be thermal, mechanical or chemical.

When it comes to oral hygiene, the art teaches a wide variety of devices with dental floss. Generally, a dental floss contains thread or fibers that is used to remove food particles and

plaque from the teeth. Dental floss contributes to the overall hygiene of a person s oral cavity and in particular to the teeth and gums. However, the use of dental floss would not necessarily prevent that person from diseases or health deterioration of the structures in an oral cavity. One of the reasons is that the use of dental floss requires a special technique to ensure that unwanted particles are removed from the teeth instead of being push down towards the gums or left on the teeth. Another reason is the difficulty to assess what has been removed, to determine where the dental floss is at work and to avoid damage to the gums. Yet another reason is that a clean dental floss is required every time a user attempts to remove food particles and plaque from the teeth to avoid accumulation of these unwanted particles on the dental floss. The current use of dental floss results in a timely and sometimes frustrating process, without guaranteed success, that could result in people avoiding flossing their teeth.

The currently available dental floss does not provide any hygienic effect that could be provided by the application of light. Accordingly, there is a need for a new dental floss that would be able to provide light treatment to oral cavities and promote the use of dental floss.

SUMMARY OF THE INVENTION

The present invention provides a device (also referred to as floss or dental floss) for light treatment at a body structure such as an oral cavity. The device includes a container capable of hosting one or more light sources. Each light source is capable of delivering a light beam that provides a light treatment. A filament is optically connected to the light

source and stored in the container. The filament is a strand or fiber of a material transparent to the light beam. The filament is thin enough to allow movement of the filament in between teeth. A portion of the filament can be pulled out from the container through an opening in the container and used in direct contact with a body structure or at a distance to the body structure. A means to turn on the light source is used after which the light beam radiates through the pulled out portion of the filament at the body structure.

The light source could be a low power laser, a light emitting diode or a semiconductor laser to provide a light beam from the ultraviolet, visible or infrared spectrum. The types of light treatments that could be selected could include any of the following effects, such as an anti-inflammatory effect, a preventative effect, an anti-bacterial effect, a sterilizing effect, a heating effect, a caries-protective effect, plaque removing effect, a teeth-whitening effect, a cleaning effect, a cosmetic effect, a therapeutic effect, a healing effect, a bio-stimulative effect, a bio-altering effect, a pain-releaving effect, an agent penetrating effect, a photo-rejuvinating effect, a photo-dynamic treatment effect or a tissue stimulating effect. The light source could be controlled in a pulsed manner and a continuous manner. It would also be possible to select one or more parameters of the light source and therewith the light treatment.

In one aspect, the container could include a cutting means to cut the pulled out portion of the filament. In another aspect, the container could include a retracting means to retract a pulled out portion of the filament back into the container. In still another aspect, a holding

means could be include to assist in holding the filament for instance during use or to minimize or avoid radiation of the light to the hand or fingers. In still another aspect, a means to close the opening of the container could be included to minimize or avoid dirt or dust entering into the container. In still another aspect, a means to pull out a portion of the filament could be included.

In still another aspect, a selection means to select parameters of the light treatment could be included. The container could include also two or more light sources each capable of delivering a unique light treatment. In this aspect the filament is transparent to the light of each of the two or more light sources. The selection means could then also include means to select one of the two or more light sources. The container includes mechanisms to optically connect the selected light source with the filament.

In yet another aspect the device of the present invention could be combined with a conventional toothpick. The toothpick could also be a toothpick capable of providing a light treatment. Such a toothpick is then optically connected to a light source to radiate a light beam with a light treatment through the toothpick at a body structure. In yet another aspect an agent could be used and applied to the body structure before, during or after the application of the light treatment. Such agents could work as a catalyst, soother or enhancer to the body structure.

BRIEF DESCRIPTION OF THE FIGURES

The objectives and advantages of the present invention will be understood by reading the following detailed description in conjunction with the drawings, in which:

FIG. 1 shows an example of a light treatment at a body structure according to the present invention;

FIG. 2 shows an example of a device according to the present invention;

FIG. 3 shows an example of an optical connection between the light source and the filament according to the present invention;

FIG. 4 shows an example of a means to hold the filament, a means to pull out the filament or a means to close the opening of the container according to the present invention;

FIG. 5 shows an example of multiple light sources and a selection means according to the present invention;

FIG. 6 shows an example of a floss combined with a toothpick according to the present invention;

FIG. 7 shows an example of a flexible waveguide according to the present invention; and

FIG. 8 shows an example of a container with a lid according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Although the following detailed description contains many specifics for the purposes of illustration, anyone of ordinary skill in the art will readily appreciate that many variations and alterations to the following exemplary details are within the scope of the invention. Accordingly, the following preferred embodiment of the invention is set forth without any loss of generality to, and without imposing limitations upon, the claimed invention.

The present invention provides a device capable of applying one or more light treatments to body structures such as the ones in an oral cavity. The device is also referred to as a floss or dental floss. These light treatments are established by one or more light sources each capable of delivering a light beam with a unique light treatment to, or in between, the body structures. The application of light treatments could be established either in a quasi-stationary manner or a dynamic manner by moving the filament (See *infra* for description of filament) with respect to the body structure. The light sources are preferably low power light sources including low power lasers, light emitting diodes or low power semiconductor lasers (See, for instance, the following companies which are listed for purposes of illustration and should not be regarded as limiting to the invention: *Coherent Inc., Santa Clara, CA*; *Microlasers by PolyScientific Inc., Blackbury, VA*; *Photonic Products, Bishops Stortford, United Kingdom*; Organic LEDs by *Covion Organic Semiconductors GmbH, Frankfurt, Germany*; Blue light emission from porous silicon by *University of Science and Technology of China in Hefei*). The desired light treatment(s) that one would like to obtain guides the choice of the light source (light sources) and the parameter(s). By varying

parameters such as continuous or pulsed (slow or fast), repetition rate, pulse duration different light treatments could be established.

In general, light treatments are defined as treatments with hygienic effects that relate to the cleanliness of these structures, promotion and preservation of health of the structures, freeing the body structure from disease-causing microorganisms or providing therapeutic effects. In particular, the present invention encompasses hygienic effects related to the hygienic effect of visible, near ultraviolet and infrared light on these structures, which are known in the art (for a light spectrum refer to page 13 in a book by *Tuner* et al. (1996) entitled "*Laser therapy in dentistry and medicine*" and published by Prisma Books, Grangesberg, Sweden). Examples of such hygienic effects that could be selected include anti-inflammatory effects, preventative effects, caries-protective effects, plaque-removing effects, teeth-whitening effects, heating effects, anti-bacterial effects, tissue stimulating effects, sterilizing effects, cleaning effects, cosmetic effects, therapeutic effects, healing effects, bio-stimulative effects, bio-altering effects, pain-releaving effects, photo-rejuvination effects, photodynamic effects or agent-penetration effects.

To establish a particular hygienic effect at a body structure one needs to consider the light source properties such as the type of light source, wavelength of the light beam, the continuous or pulse mode (e.g. slow or fast) of operation of the light source, characteristics of the structures, water content of the structures, pigmentation degree of the structures, vascularization of the structures, vitality of the structures, heterogeneity of the structures,

specific heat conductivity of the structures, the fluence of light penetration through a structure or the time exposure needed for the light beam. The art provides teachings on hygienic photo-effects of structures including guidelines regarding parameters such as the type of light source, selection of wavelength(s), fluence, penetration, recommended pulse duration, recommended repetition rate, or the like. The selection of the hygienic effect as part of the present invention incorporates these teachings as well as new teachings that become available in the art describing newly identified hygienic effects.

Currently available teachings are described in the following books, which provide an exemplary list rather than a comprehensive list. The list includes a book by *Goldman* (1981) entitled "*The biomedical laser: technology and clinical applications*" and published by Springer-Verlag, New York; a book by *Katzir* (1993) entitled "*Lasers and optical fibers in medicine*" and published by Academic Press, New York; a book by *Hajder* et al. (1994) entitled "*Acupuncture and lasers*" and published by Ming, Belgrade; a book by *Tuner* et al. (1996) entitled "*Laser therapy in dentistry and medicine*" and published by Prisma Books, Grangesberg, Sweden; a book by *Alster* et al. (1996) entitled "*Cosmetic laser surgery*" and published by Wiley & Sons, New York; or a book by *Fitzpatrick* et al. (2000) entitled "*Cosmetic Laser Surgery*" and published by Mosby, St. Louis).

FIG. 1 shows an exemplary embodiment of a light source **110** delivering a light beam with a wavelength **112**. The wavelength **112**, e.g. a green wavelength, provides a unique hygienic effect when applied to body structure **120**. In this example, light beam **112** has a

fairly superficial hygienic effect at body structure **120** as shown by **114**. The present invention is not limited to a superficial effect and could also penetrate to deeper levels. In general, n light sources **130-1** to **130-n** could be provided from which a user can select one light source at a time. In one example, two of the same light sources could be provided such as two light sources **140-1**, **140-2** that each deliver blue light, however, with at least one different parameter to establish a different and unique hygienic effect for each of the two light sources **140-1**, **140-2** that can be selected by a user. The different and unique hygienic effect in this example was established by different fluences for each of the two light sources **140-1**, **140-2**, i.e. **fluence 1** and **fluence 2**, respectively. In another example three light sources could be provided, of which two are the same **150-1**, **150-2** and one **150-3** is different, though all three delivering a unique hygienic effect. The different and unique hygienic effect in this example between **150-1**, **150-2** was established by having the same light source **150-1** and **150-2** but with a different mode such as continuous mode or pulsed mode respectively.

FIG. 2 shows an example of a device that includes a container **210** and a filament **220** (**200-A, 200-B, 200-**C are different perspective views of the same device). Container **210** hosts a light source **230**, which is capable of delivering a light beam **240**. Light source **230** is powered by a power supply **250**, such as a (rechargeable) battery. Power supply **250** is connected to a means to turn on light source **230** shown in this example as a switch **260**. Switch **260** is preferably positioned at the outside of container **210** (e.g. at a side or bottom)

and controls the on/off stage of power supply **250** and therewith the on/off stage of light source **230**.

Filament **220** is optically connected to light source **230**. Filament **220** is a strand or fiber of a material transparent to the light beam produced by light source **230**. The filament is thin enough and flexible enough to allow movement of the filament in between the teeth. Examples of filaments are for instance, but not limited to, soft fibers, doped fibers (silicone or latex doped), colored or colorless fibers, or the like. Once filament is illuminated, it becomes a glowing filament that radiates a selected light treatment. Generally speaking, the light beam radiates through the surface of the transparent filament and could be used at a distance or in direct contact with a body structure.

FIG. 3 shows an example of how filament **310** could be placed inside a holder **320** to align the output of light source **330** with filament **310**. The position of filament **310** inside holder **320** could for instance be ensured by squeezing holder **320** so that openings **322** come closer together. In one aspect, one or more optical elements (e.g. a (collimator) lens **340**) could be used to promote that the light beam travels from light source **330** into filament **310**.

Filament **220** is stored in container **210**, preferably as a spool **222**. However, filament **220** is not limited to be stored as a spool and could be stored in any other way as long as filament **220** can be optically connected to light source **230** and can be pulled out from

container **210** through opening **212**. In one aspect, a means could be included to hold filament **220**, then referred to as a holding means **410** as shown in **FIG. 4**. The holding means could provide a user with a convenient device that could make the application of the filament easier. The holding means could be made out of a non-transparent material (at least to the selected light beam) to avoid radiation to a user's hand or fingers. The holding means could take any shape and is not limited to the shape of holding means **410** as shown in **FIG. 4**. However, it would be preferred to have an ergonomically shaped holding means that easily fits a user's hand. Different shapes and sizes would then accommodate the shapes and sizes of the hands of children and adults. Holding means **410** could include an easy quick-connect or clip **420** to connect to filament **430** which are known in the art. Open position **422** allows filament **430** to enter quick-connect or clip **420**. In one aspect, holding means could be used as a means to pull out a portion of the filament from the container. In another aspect holding means could be used a lid **440** to close opening **212** to prevent dirt or dust to enter container **210**. The means to hold, pull and close can be the same elements, all combined in one, or could be separate elements that could be used in combination with the container and filament.

In the example of **FIG. 2**, light source **230** is placed on a rod **270** that rotates inside or around **272** when filament **220** is pulled out from container **210**. In one aspect, rod **270** could include a mechanism that retracts the pulled out portion of filament **220** back into container **210**. Such retraction means are known in the art (e.g. used in tape measures, cable devices, or the like). Typically a push on a button enables the retraction means to

release its holding position and retract the pulled out portion of filament **220**. For obvious reasons, if a retraction means is used one would need to consider that the end of the filament remains outside of the container. A holding means or a lid holding the filament would be preferred so that the next time the user wants to use the filament it can easily be pulled out from the container.

As discussed *supra*, more than one light treatment could be selected. **FIG. 5** shows an example of a container **500** hosting and capable of selecting three light sources **510 (L1, L2, L3)** each with a unique light beam and light treatment. Each light source **L1, L2, L3** could be selected and the selected light source is then optically connected to the filament for instance by a turning knob, by an automated system, a switch, a motor, or the like. One could consider different ways to optically connect or align the selected light source to the filament as well as different optical elements to promote and/or ensure proper light guidance through the filament if needed.

A selection means **520** could be included with container **502** which could have, for instance, four arrow buttons **522** and one center button **524**. Each arrow button **522** corresponds to a light source, parameter or mode that could be selected. The selection could be assisted by a displaying means **530** (optional) that provides feedback to the user about the selections or current modes of operation(s). The center button **524** could be used as a confirmation button, a turn on/off button or the like. The up, down, left and right arrow buttons could relate to the browsing or selection on the displaying means **530**.

Displaying means **530** could be any type or size of displaying means that would fit the container and is useful to the user. Necessary software and hardware components would be included to provide the functionality to display the parameters, selections and/or functions as well as provide functionality to the buttons.

The present invention has now been described in accordance with several exemplary embodiments, which are intended to be illustrative in all aspects, rather than restrictive. Thus, the present invention is capable of many variations in detailed implementation, which may be derived from the description contained herein by a person of ordinary skill in the art. In one variation as shown in **FIG. 6** a toothpick **610** could be added to device **620**, device **620** is similar to the device as taught *supra.* Filament **630** could be pulled through opening **640** (in plane of drawing) and potentially held in place by for instance a spring-loaded pin **650**. The toothpick could be a regular toothpick as know in the art or a toothpick that could be optically connected to a light source and therewith providing a light treatment (See U.S. Patent Application 10/645674 entitled *A toothpick for light treatmenr of body structures* by the same inventor as the present application with filing date 08/20/2003 for teachings of such a toothpick, which is hereby incorporated for all that it discloses). The light source optically connected to the toothpick could be a separate light source with its own control or could be the same light source as for the filament. In case a different light source is used for the toothpick, there is a choice whether the same or a different light treatment for the toothpick could be used compared to the light treatment for the filament. In any event, the toothpick would glow when illuminated by a light beam from a light source. In another variation a flexible waveguide **710** could be used instead of

a filament as shown in **FIG. 7**. The difference between the flexible waveguide and the filament is that the flexible waveguide is not necessarily transparent and could therefore include openings **720** to allow passage of light **730**. In still another variation the filament is a removable, a disposable, a reusable or a replaceable filament. The filament **810** could be placed in container **820** by opening and closing lid **830** of container **820** as shown in **FIG. 8**. Once filament **810** is placed inside container **820**, it can be optically connected to light source **830** through connection **840** (See also **FIG. 3**). Light source **830** could be pivotally placed or connected to lid **830** to allow the spool of filament to easily unroll when pulled out. In still another variation an agent could be used and applied to the body structures before, during or after the application of the light treatment. Examples of agents are for instance bioprotective agents, photocatalyst, treatment gels or cream, soothing agents, tissue permeation enhancers or the like (See, for instance, the following companies/products which are listed solely for purposes of illustration and should not be regarded as limiting to the invention: *Neova by Procyte Corp. www.procyte.com*; *Medicalia Inc. www.medicalia.com*; or *ESBA Laboratories Inc.*). Such agents could work as a catalyst, soother or enhancer to the body structures. All such variations are considered to be within the scope and spirit of the present invention as defined by the following claims and their legal equivalents.